Instruction and Maintenance Manual

RADIOLOGICAL SURVEY METER

OCDM ITEM NO. CD V-700, MODEL 5

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MANUFACTURED BY
ANTON ELECTRONIC LABORATORIES, INC.
BROOKLYN 37, NEW YORK
1959 - 60

ERRATA SHEET

(Affix to inside front cover)

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1. Please insert capacitor, C8 (0.0025uf 1.4KV) between B and C of V4 on schematic.
2. Please change value of R14 from 1 megohm to 6.8 megohm.
3. On T1 reverse numbers 2 and 3.

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1. Physical location of C8 is lower left hand corner adjacent to top of V5.

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1. C1 should be 1.4KV.
2. Please change R14 to read 6.8 megohm ½ watt 10%.
3. Please change R13 to read 910 ohm ½ watt 5%.
4. Please add to parts list:

Schematic Symbol	Quantity per Equipment	Description and Function	Supplier	Suppliers Part No.	AEL Part No.	Rec. Spares for 5 Units
C8	1	Capacitor 0.0025 uf + 100% - 20% 1.4 KV; stabilizes HV power supply	GDL	Type B	106-177	1

Additional Space for Notes:

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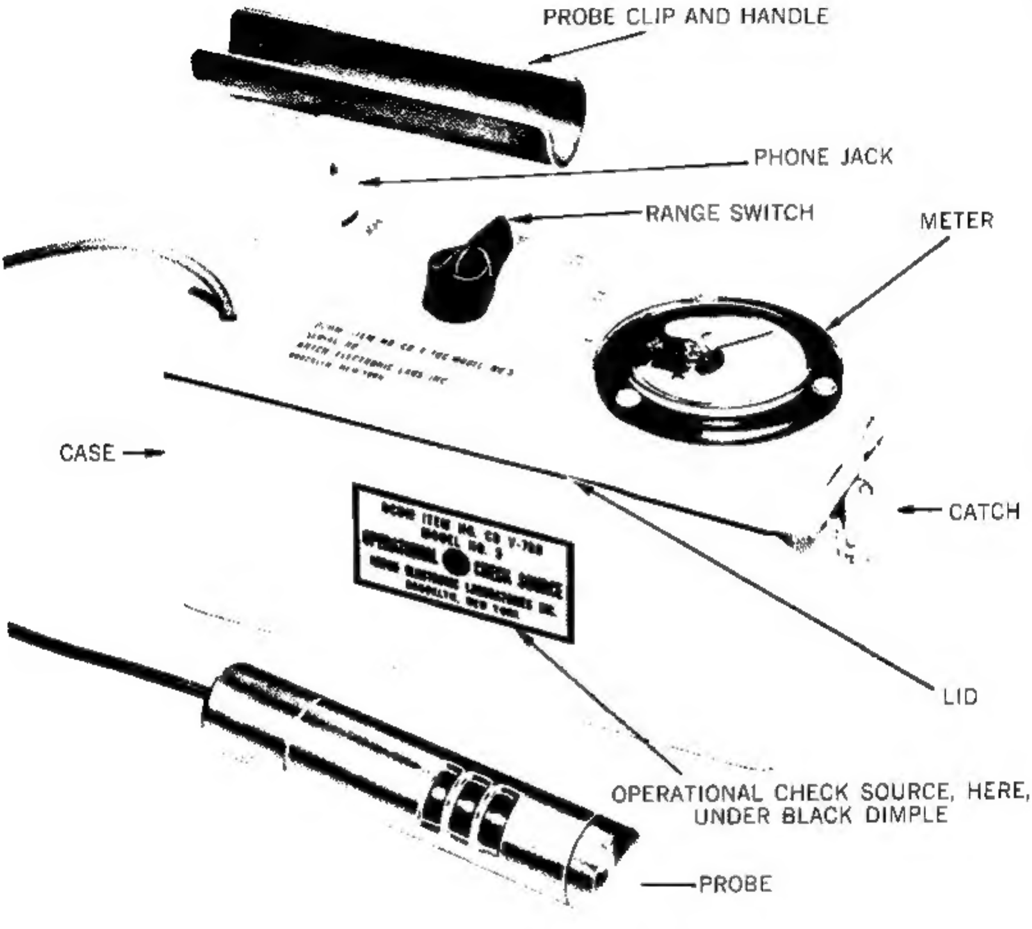

Fig. 1 — Anton CD V-700 Survey Meter

I. GENERAL DESCRIPTION

1.1 INTRODUCTION

The Anton V-700 is a portable, battery powered, transistorized survey meter with a regulated power supply using an Anton type 114/6993 stainless steel, halogen quenched Geiger-Mueller tube as the detector. The geiger tube is mounted in a probe connected to three feet of cable. The instrument and its accessories include a circuit chassis, a probe, a headphone, a carrying strap and a radioactive source mounted under the name plate. (See Fig. 1 and cover photo)

1.2 THE PROBE

The probe consists of a nickel plated brass housing with a spring loaded window which may be opened in order to admit beta radiation. The probe contains the geiger tube which is sensitive to moderate and high energy beta radiation and to gamma radiation down to low energies. The geiger tube is mounted through a rubber gasket and is held in place by a coil spring. (See Fig. 2)

1.3 THE CIRCUIT CHASSIS AND CASE

The circuit chassis and case consists of the 5 each 1½ volt type D supply batteries, a transistorized pulse shaping network, a detecting (metering) circuit, a regulated transistorized high voltage power supply, an audio pulse amplifier and a radioactive Radium D+E source. The system is shock proof and water proof, and is secured with rapid takedown clamps in order to make access very simple. The battery bracket faces out for rapid removal and replacement of batteries, and protection of the circuitry from battery "leakage".

1.4 THE HEAD SET

The head set is a single piece magnetic phone with a connector mated to the watertight jack mounted on the lid. The watertight jack is kept covered by a plastic dust cover.

1.5 THE CARRYING STRAP

The carrying strap is made of plastic. It is provided with adjustment clips. The strap is adjustable from 30 inches to 60 inches in length.

II. THE THEORY OF OPERATION

2.1 INTRODUCTION

This instrument consists of a halogen quenched beta-gamma geiger tube radiation detector, a regulated power supply, a transistorized pulse shaping and metering network, an indicating meter, an audio pulse amplifier and head phone for audible monitoring of activity.

Fig. 2 — Exploded view of Probe and Tube Assembly

2.2 THE GEIGER TUBE

The geiger tube consists of a thin cylindrical shell which is the cathode, a fine wire anode suspended along the longitudinal axis of the shell, and an inert gas into which a small amount of a halogen gas is inserted to act as a quenching agent. A voltage slightly less than that required to produce a discharge is applied between the anode and cathode. When a beta particle of sufficient energy impinges upon the tube, some of the particle's kinetic energy is used to ionize a gas molecule. The electrons, resulting from this ionization, are accelerated toward the anode by the electric field and in movement toward the anode cause additional ions to be formed. Similarly, gamma rays impinging upon the cathode wall cause secondary electrons to be ejected which in turn become the ionizing event. The creation of additional ions is very rapid thus producing a discharge in the gas. The small amount of halogen gas in the tube serves to help in quenching the discharge without self-consumption and restores the tube to its original condition. This discharge results in a pulse in the external circuit. The frequency of such pulses is proportional to the intensity of radiation field.

2.3 THE HIGH VOLTAGE SUPPLY

The high voltage supply consists of a blocking oscillator circuit in which pulses are generated by a transistor, V4, alternately cut-off and saturated. The transformer windings between the base and collector are so phased that when the collector current starts to flow, the voltage at the base goes in the negative direction. By virtue of the base going negative, the collector current will increase still further causing the base to go more negative. The collector current increases until the transistor saturates, at which point the collector cannot supply the current demanded by the signal at the base. At this point, since there is no rate of change of current in the transformer, there is no signal induced in the base winding. Therefore, the emitter current decreases, decreasing the collector current. The signal then induced at the base of the transistor is such as to make this action cumulative until the transistor cuts off. The collector current stops abruptly, causing a large rate of change of current in the transformer. This makes the base go negative, which in turn starts the collector current flowing and the cycle repeats.

The step-up turns ratio between the collector winding and the secondary winding produces a high voltage pulse, which is then rectified by the selenium rectifier, CR2.

The D.C. output voltage developed across capacitor, C-7, is regulated by the corona discharge voltage regulator tube, V5. This regulation stabilizes the voltage supply to the Geiger-Mueller tube for battery voltages within the normal operating range. The high voltage is regulated at 930 volts $\pm$ 20 volts.

2.4 THE PULSE SHAPING AND METERING CIRCUIT

The pulse shaping and metering circuit is composed of two transistors, a rectifier and a meter. Transistors, V1 and V2, form an emitter coupled, monostable multivibrator. A negative pulse from the

Geiger tube is coupled to the base of V1, the normal cut-off transistor. This pulse causes V1 to conduct, and a positive pulse is developed on its collector. The positive pulse is coupled to the base of V2 through the timing capacitor and cuts off transistor, V2. The resulting negative pulse on the collector of V2 is coupled to the base of V1 by the resistive voltage divider consisting of R2 and R3. This condition with V1 conducting and V2 cut off will continue for a period determined by resistor, R10, and the time capacitor selected by the range switch. The voltage pulse at the collector of V1 is rectified by silicone rectifier, CR1, and fed to the meter, M1. The voltage pulses at the meter are integrated by capacitor, C5. The average voltage indicated on the meter is proportional to the frequency of the input pulses. The pulse frequency is proportional to the radiation field intensity, and the meter can therefore be calibrated to indicate the dose rate directly in milliroentgens per hour.

2.5 SCALE RANGES

Three operating ranges (X1, X10, X100) as calibrated with a Radium D + E standard are provided. These correspond respectively to 0.5 milliroentgens per hour, 5 milliroentgens per hour and 50 milliroentgens per hour equivalent radiation. The scales also indicate approximate counts per minute. Scale changing is effected by switching capacitors, thus changing the pulse width of the multivibrator.

2.6 THE AUDIO PULSE AMPLIFIER AND HEAD PHONE

Aural monitoring is achieved by a transistorized pulse amplifier and a head set. Each pulse counted by the pulse shaping circuit develops a negative pulse at the collector of V2. This pulse is differentiated and coupled to the base of V3. Transistor, V3, is connected as an emitter coupled amplifier which drives the step up pulse transformer, T1. The secondary of the pulse transformer is connected to the head phone jack. When the 4000 ohm head set is connected at the jack a pulse of approximately 15 volts is developed across the head set resulting in a clear audible click.

III. INSTALLATION

3.1 INSTALLING THE BATTERIES

The instruments are shipped with the batteries packed separately. To put the instrument into operation:

1. Open the case by releasing the clamps at both ends, and remove the lid assembly.
2. Remove the batteries from their package, taking care not to drop them.
3. Loosen knurled battery clamp nuts and remove clamps.
4. Place the "D" cell batteries, negative end first, against the "finger" springs and slide the positive terminals down in their respective grooves. The batteries will all be facing the same

way. The housing is designed to assure correct polarity. (See Fig. 3)

5. Replace clamp — tighten the knurled nut.
6. Replace lid assembly on case.

IV. OPERATION

4.1 OPERATING THE UNIT THE FIRST TIME

With probe in the handle clip, switch the instrument to the times ten (X10) scale with the beta window closed. Wait 30 seconds. The meter should read substantially zero. Present the open window of the probe to the center of the nameplate under which is a radioactive sample (See Fig. 1), make sure the geiger tube is directly over the dimple on the nameplate. The indicator should fall between 1.5 milliroentgens per hour (mr/hr) and 2.5 mr/hr, averaging about 2.0 mr/hr.

4.2 CALIBRATION ADJUSTMENT

Note: The radium D + E beta source under the nameplate should be the only source of radiation. Calibration adjustment must not be undertaken when the background is above normal (Sect. 4.5) or in a radiation field other than that produced by the known beta source under the nameplate.

If the meter indication differs from the above, it may be corrected by adjusting the screw of the potentiometer, R6, as shown in Fig. 4. To gain access to this potentiometer, loosen both clamps, remove the instrument from the case and tilt the instrument to one side. Use a screwdriver. Advancing the screw clockwise increases the reading; rotating it counter-clockwise decreases the reading.

Note: The half-life of Radium D+E is approximately 22 years, therefore:

Year	1962	1965	1968	1970
% of original source strength	94%	85%	78%	73%

4.3 "ON-OFF" AND RANGE SWITCH

The range switch controls an "OFF" position and three ranges labeled, "X100," "X10," and "X1." These are respectively 100 times, 10 times and 1 times the scale reading in mr/hr and counts per minute. The printed meter scale goes to 0.5 mr/hr and 300 counts per minute respectively.

4.4 USING THE HEAD SET

To use a head set, the phone connector is attached to the terminal located immediately to the left of the post of the handle. In using the head set the counting rate is indicated by distinct clicks, the frequency of which is equal to the count rate.

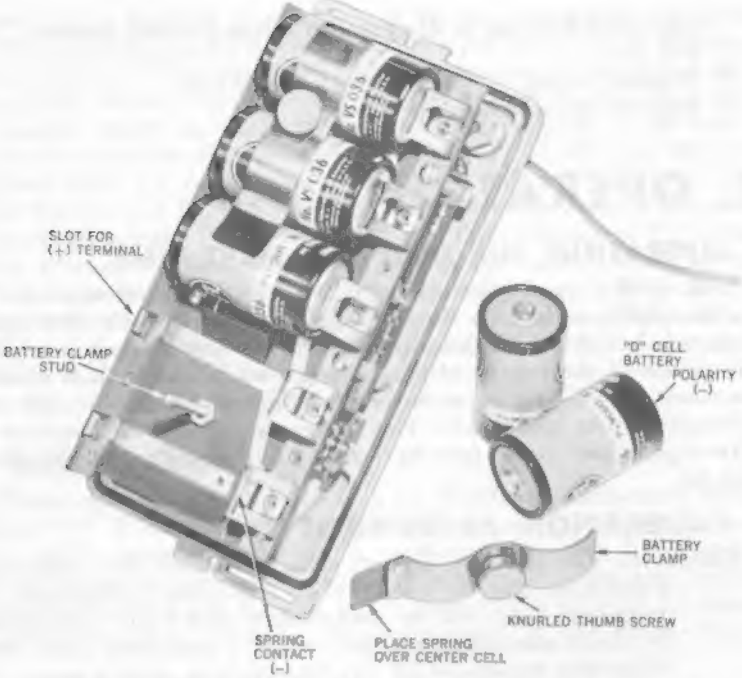

Fig. 3 — V-700 Showing Battery Section

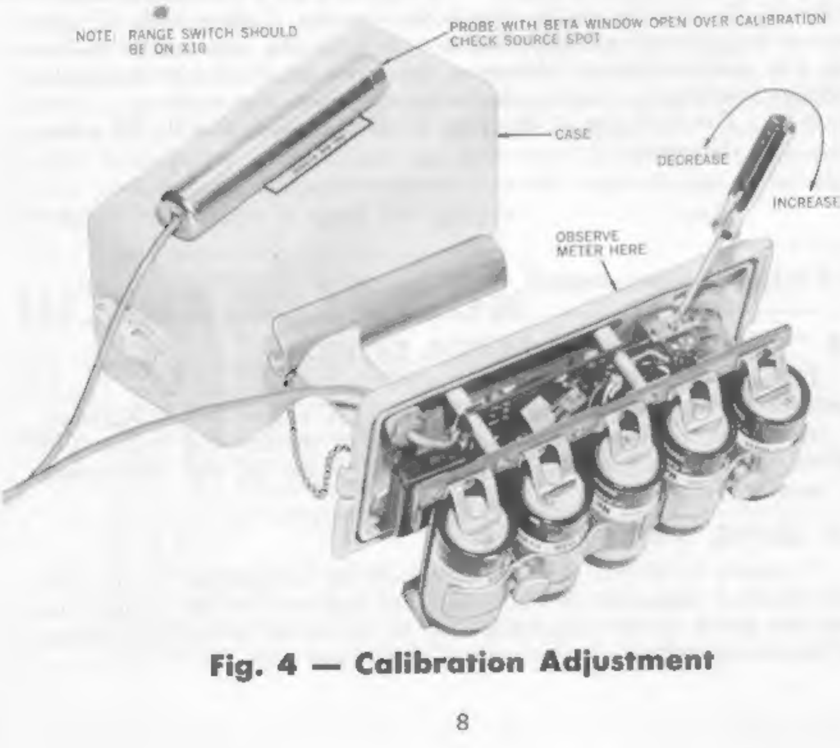

Fig. 4 — Calibration Adjustment

4.5 NORMAL BACKGROUND

Since normal background of radioactivity will be in the order of 0.01 to 0.02 mr/hr, as recorded on this type of instrument, little activity will normally be seen or heard. Under background conditions only, about 20 per minute of these "clicks" will occur. They are randomly spaced so that one may wait for several seconds before any "click" is heard; then there may be two or three.

4.6 CHECKING CALIBRATION

The operator should periodically check the calibration of the instrument to verify that it is correct. This operation is described in paragraph 4.2. Precise recalibration should be done with approved standards in a radiology laboratory.

4.7 USING THE CARRYING STRAP

The instrument may be carried in the hand or by a strap over the shoulder. The strap anchors are arranged in such a way that the meter is visible when carried over either the left or right shoulder. Quick "connect and disconnect" fasteners are provided.

V. PREVENTIVE MAINTENANCE

5.1 BATTERY LIFE

Caution: *Make Certain the Instrument is Turned OFF Whenever Not in Use.* ("OFF" position places the range switch perpendicular to the handle axis.) The life of the batteries is at least 100 hours under continuous use; for intermittent use the life may be extended. The indications that the instrument is ON are: (a) the position of the range switch, (b) clicks in the head phone.

5.2 STORAGE

The instruments are shipped in a packing container and should be left this way until ready to be put into operation. This prevents the accumulation of dirt, moisture, and radioactive contamination, which would interfere with proper operation of the instrument. For storage purposes it is best, wherever possible, to keep the instrument in a moderately cool area, as this will provide greater shelf life for the batteries. At all times one should attempt to prevent contamination of the instrument and particularly the probe. The instruments should not be stored with the batteries installed.

5.3 DECONTAMINATION

Because this equipment may be used in areas where radioactive contamination is possible, it is recommended that the instrument, probe and accessories be cleaned (after exposure to such condition) in an accepted manner to avoid both spurious counting or residual radiation hazards.

The probe housing has been specifically designed to permit decontamination. To clean its parts, unscrew the cap end; slide the beta shield sleeve off the housing. All the component parts of the probe may now be cleaned. (See Fig. 2)

5.4 BATTERY INSPECTION

Even under continuous use with leak-proof cells, it is advisable to check the batteries for leakage at least once per month.

VI. OPERATOR'S MAINTENANCE

6.1 REPLACING THE BATTERIES

Whenever the instrument fails to respond to the operational check source, check the batteries. To replace the "D" cells, see Paragraph 3.1. If a voltmeter is available, one can check the "D" cells. Cells showing signs of corrosion or providing less than 1.5 volts should be replaced at this time.

6.2 REPLACING THE GEIGER TUBE

The chief maintenance required by this instrument is replacing the batteries (see Paragraph 6.1). The geiger tube is halogen quenched so that its operating life is unaffected by use and therefore rarely requires replacement. However, if fresh batteries are installed, and the instrument still does not work correctly, it is preferable to check it with a new geiger tube before making any further attempts at circuit checking.

Caution: *In Removing or Replacing Geiger Tube Do Not Grasp Tube at Thin Section. (See Fig. 2)*

VII. CORRECTIVE MAINTENANCE

7.1 IN CASE OF DIFFICULTY

Open case and make visual inspection for shorts, broken wires, and obviously damaged or broken components.

7.2 CHECKING HIGH VOLTAGE POWER SUPPLY

Measurements in the high voltage power supply must be made with a high impedance voltmeter. Either an electrostatic voltmeter or a vacuum tube voltmeter with a high voltage probe having an input impedance of 1,000 megohms or higher should be used. With an instrument of this type, the high voltage may be measured between pins 1 & 3 (pin 1 is positive) of the Geiger tube socket. The probe cover and the Geiger tube must be removed to make the pins of the socket available for this measurement. The voltage between pins 1 & 3 of the tube socket will normally be 930 volts $\pm$ 20 volts.

If a high impedance meter is not available, a sensitive microammeter may be used in conjunction with a large resistor. If a 500 megohm resistor is used, a current between 1.7 and 1.9 microamperes should be measured. Should the high voltage check incorrectly, the following tests should be made:

1. Check the batteries with the instrument turned on. The 4.5 volt supply should read at least 4.2 volts. The 3 volt supply should read at least 2 volts.

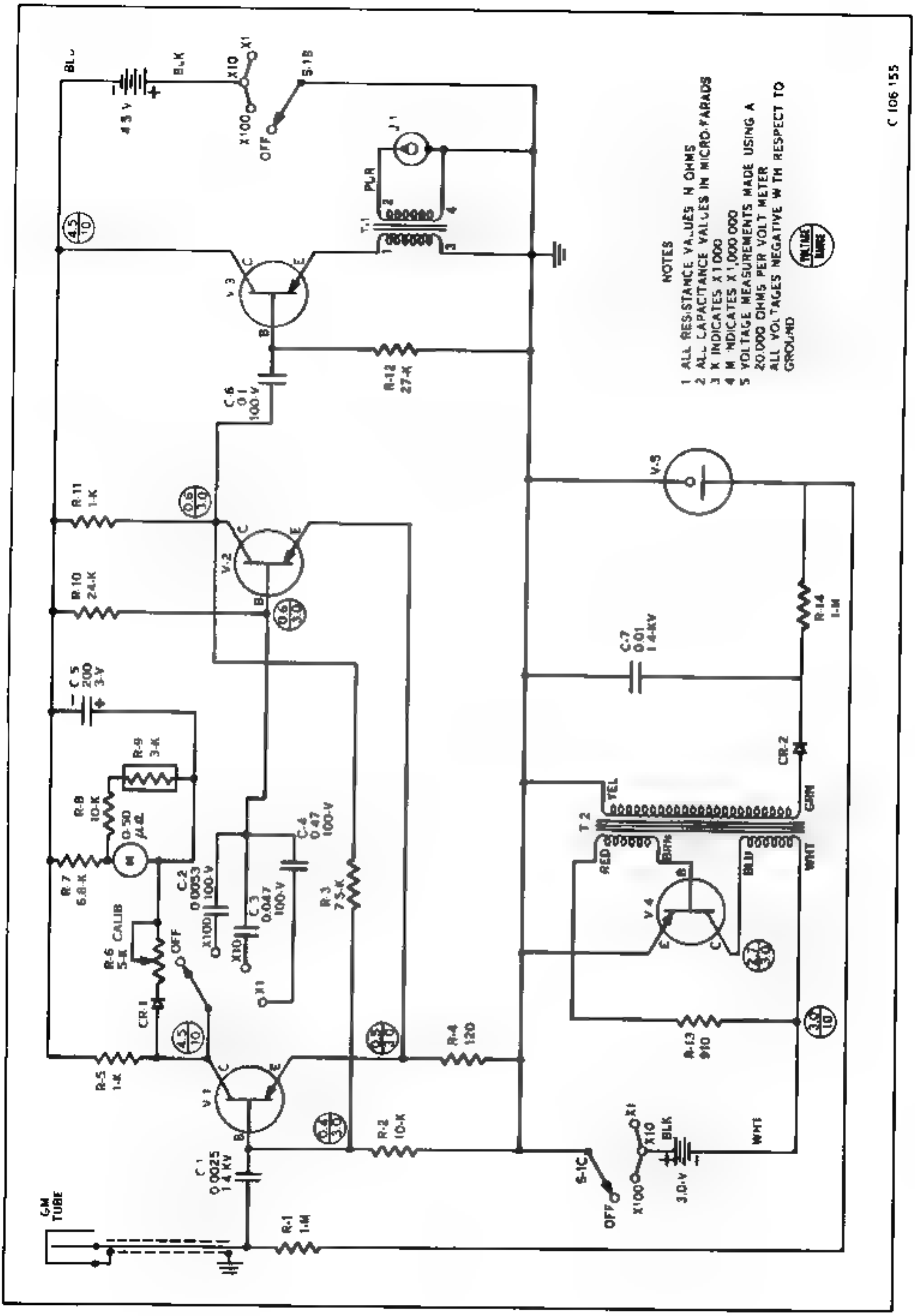

Fig. 5 — Schematic for V-700

2. If the high voltage is low, check the voltage at the collector of transistor, V4. This voltage should be at least 1.7 volts. If this voltage is low, replace V4. If the collector voltage is sufficiently high, but the output voltage is still low, replace rectifier, CR2.
3. If the high voltage is higher than 950 volts, replace the VR tube, V5.

7.3 CHECKING THE PULSE SHAPING NETWORK AND INTEGRATING CIRCUIT

In order to check the pulse and integrating circuit, connect the head phone and listen while tapping pin 1 of the Geiger tube socket with an insulated screwdriver (Note: Do not touch the shaft of the screwdriver or ground it to the case.). This should create a series of clicks in the head phone and should cause the meter to deflect when the range switch is in the X1 position. If no clicks are heard, try the same test by touching the screwdriver to junction R1-C1. If this produces clicks, the cable assembly is defective and must be replaced. The cable assembly is permanently potted at the connector and, therefore, cannot be repaired. If no clicks are heard when tapping the junction, check the voltage at transistors, V1 and V2, as indicated on the schematic drawing. If the voltages are correct, replace capacitor, C1. If the voltage on the collector of V2 is too high, replace V2.

If tapping the junction produces clicks, but the meter does not deflect, replace CR1, R6, R7 and C5 in that order, checking after each replacement. If the meter deflects and returns quickly at the zero position, replace C5. If none of the above replacements produces a meter deflect, replace the meter.

7.4 CHECKING THE AUDIO PULSE AMPLIFIER

If the meter is functioning, but no clicks are heard in the head phone, first check the connection of the head phone plug to the jack on the lid of the equipment. If clicks are still not heard, replace V3; and if this fails, replace T1 followed by C6 if the trouble is not cured.

7.5 OHMMETER AND VOLTMETER CHECK

If the instrument is inoperative after the above checks, a resistance check may be made with a 20,000 ohm-volt meter. A voltmeter check with the same instrument will determine if an active element (transistor) or component (resistor, capacitor, etc.) is bad.

Resistance check — The values indicated on the schematic, Fig. 5, should be measured with the switch on the OFF position, that is, with the circuit not energized.

Voltage check The values indicated on Fig. 5 should be measured with the switch on the X100 position. In this position the instrument will be energized. NOTE: Measurements should not be made in a high count rate area.

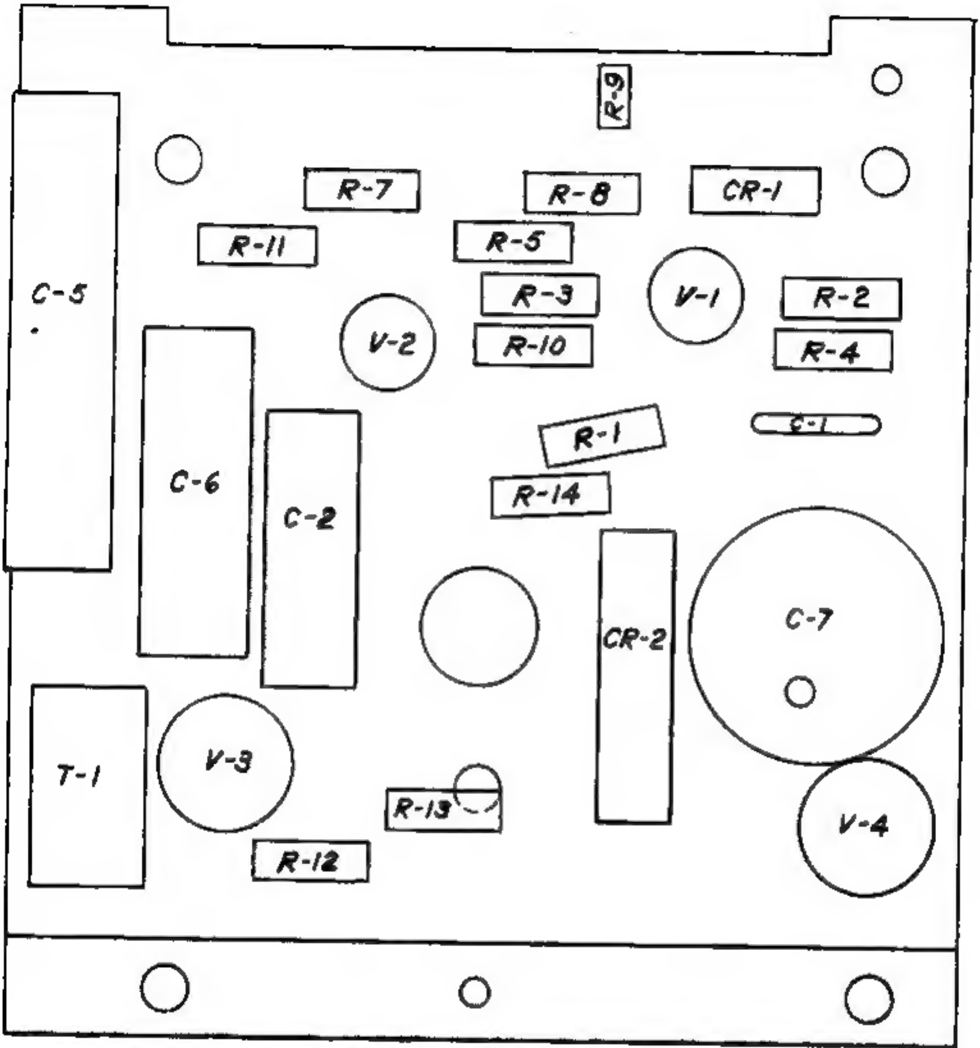

Fig. 6 — Printed Circuit Board (Component Side)

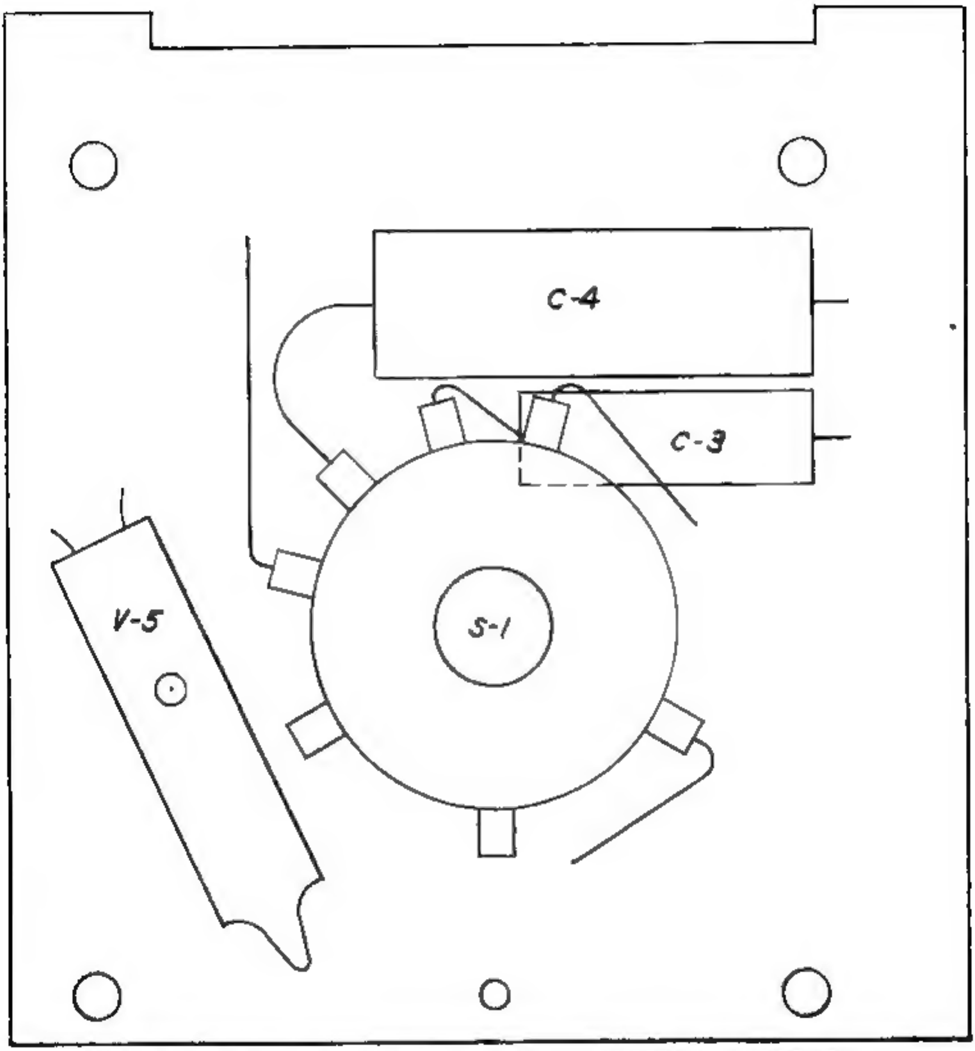

Fig. 7 — Printed Circuit Board (Wiring Side)

VIII. REPLACEMENT PARTS

8.1 ELECTRICAL COMPONENTS

Schematic Symbol	Quant. per Equip.	Description and Function	Supplier	Supplier's Part No.	AEL Part No.	Rec. Spares for 5 Units
C1	1	Capacitor 0.0025uf $^{+100\%}_{-20\%}$ 1KV Blocks H. V. and couples signal to V1	GDL	Type B	106-177	1
C2	1	Capacitor 0.005uf ±5% 100V Timing X100 Range	GDL	Type 600VE	106-178	1
C3	1	Capacitor 0.047uf ±5% 100V Timing X10 Range	GDL	Type 623	106-179	1
C4	1	Capacitor 0.47uf ±5% 100V Timing X1 Range	GDL	Type 623	106-180	1
C5	1	Capacitor 200uf 3V Integrating	Cont. Comp.	EAH 7330	106-181	1
C6	1	Capacitor 0.1uf $^{+40\%}_{-0}$ 100V Coupling to audio amplifier	GDL	Type 623	106-182	1
C7	1	Capacitor 0.01uf $^{+100\%}_{-20\%}$ 1.4KV H. V. Filter	GDL	Type G	106-183	1
R1, R14	2	Resistor 1 megohm ½W 10% VR tube load, GM tube load	IRC	BTS	106-184	1
R2	1	Resistor 10K ohm ½W 5% V1 Bias Network	IRC	BTS	106-185	1
R3	1	Resistor 7.5K ohm ½W 5% V1 Bias Network	IRC	BTS	106-186	1
R4	1	Resistor 120K ohm ½W 5% Multivibrator Emitter Res.	IRC	BTS	106-187	1
R5	1	Resistor 1K ohm ½W 10% V1 Collector Load	IRC	BTS	106-188	1
R6	1	Potentiometer 5K ohm ¼W Calibration Adj.	Chic. Tel.	Type PE-70 HR 4052	106-189	1
R7	1	Resistor 6.8K ohm ½W 10% Time Constant	IRC	BTS	106-190	1
R8	1	Resistor 10K ohm ½W 10% Temperature Compensation	IRC	BTS	106-191	1
R9	1	Thermistor 3K ohm ±10% Temperature Compensation	Vic. Eng.	33D2	106-192	1
R10	1	Resistor 24K ohm ½W 5% Multivibrator Timing	IRC	BTS	106-193	1
R11	1	Resistor 1K ohm ½W 5% V2 Collector Load	IRC	BTS	106-194	1
R12	1	Resistor 27K ohm ½W 10% V3 Base Return	IRC	BTS	106-195	1
R13	1	Resistor 910K ohm ½W 5% V4 Base Bias	IRC	BTS	106-196	1
GM	1	Geiger Tube Detector	AEL	6993	6993	1
SW-1	1	Switch — Changes Ranges	AEL	106-100	106-100	1
M	1	Meter 0—50ua Indicates Radiation Intensity	AEL	106-101	106-101	1
B	5	Batteries "D" Size 1½ volt Supply Power	N.C.	950	106-198	25
T1	1	Transformer, Pulse step-up Audio Pulse	AEL	106-102	106-102	1
T2	1	Transformer, Blocking Oscillator & HV Step up	AEL	106-121	106-121	1
CR1	1	Rectifier — Meter Rectifier	AEL	106-28	106-28	1
CR2	1	Rectifier — H. V. Rectifier	Int. Rec.	61-5967	106-29	1
V1	1	Transistor Multivibrator	GT	1437	106-199	1
V2	1	Transistor Multivibrator	GT	1436	106-200	1
V3	1	Transistor Audio Pulse Amplifier	GT	1459	106-201	1
V4	1	Transistor H. V. Power Supply	GT	1438	106-202	1
V5	1	Voltage Regulator Tube	AEL	106-197	106-197	1
PB	1	Printed Circuit Board	AEL	106-117	106-117	
H	1	Head Phone	AEL	106-176	106-176	1

8.2 MECHANICAL COMPONENTS

Quant. per Equip.	Description and Function	Supplier	Supplier's Part No.	AEL Part No.	Rec. Spares for 5 Units
1	Meter Gasket	AEL	106-103	106-103	2
1	Knob, Pointer	H.D.M.	2110E	106-175	2
1	Jack, Head Phone Connector	AEL	106-131	106-131	1
1	Jack Gasket	AEL	106-110	106-110	2
1	Probe Cable Assembly, Hold GM Tube	AEL	106-158	106-158	1
1	Battery Holder Assembly	AEL	106-104	106-104	1
1	Gland, Water Seal & Hold Probe Cable	AEL	106-106	106-106	1
1	Panel, Top Cover	AEL	106-119	106-119	1
1	Panel Gasket	AEL	106-107	106-107	2
1	Handle Assembly — Holds Probe	AEL	106-108	106-108	1
1	Handle Gasket	AEL	106-109	106-109	2
1	Case Assembly, Bottom Cover	AEL	106-116	106-116	1
1	Name Plate, Contains Operational Check Source	AEL	106-113	106-113	1
2	Battery Clamp, Holds Batteries	AEL	106-114	106-114	2
1	Cap & Chain Assembly, Cover Phone Jack	AEL	106-115	106-115	1
1	Strap Assembly, Carrying Strap	AEL	106-124	106-124	1

8.3 VENDORS

Symbol	Name	Address
AEL	Anton Electronic Laboratories, Inc.	1226-1238 Flushing Avenue, Brooklyn 37, New York
Chic. Tel.	Chicago Telephone Supply Corporation	1142-1232 W. Beardsley Avenue, Elkhart, Indiana
Cont. Comp.	Continental Components Corporation	1261 Broadway, New York, New York
GDL	Good-All Electric Manufacturing Company	Ogallala, Nebraska
G.T.	General Transistor Corporation	91-27 138 Place, Jamaica 35, New York
H.D.M.	Harry Davies Molding Company	1428 N. Wells Street, Chicago, Illinois
IRC	International Resistance Company	1101 Terminal Commerce Boulevard, Philadelphia 8, Pennsylvania
Int. Rec.	International Rectifier Corporation	1523 E. Grand Avenue, El Segundo, California
Vic. Eng.	Victory Engineering	P.O. Box 373, Union, New Jersey